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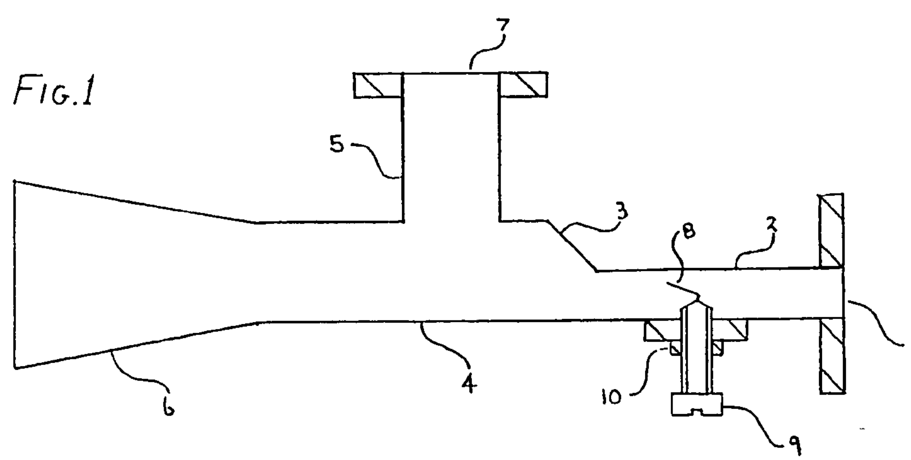
(54) **Polarization duplexer for microwaves**

(57) A microwave transmit/receive waveguide system is described, which transmits plane-polarized microwaves and responds only to orthogonally polarized reflections. Means (8, 9, 10) are provided for effecting an adjustable perturbation of the waves within the transmission channel (2), which adjustment can be used to achieve high degrees of isolation between the reception and transmission channels (5, 2). The perturbation means (8) has several degrees of freedom whereby adjustments in both phase and amplitude are possible.

FIG. 1



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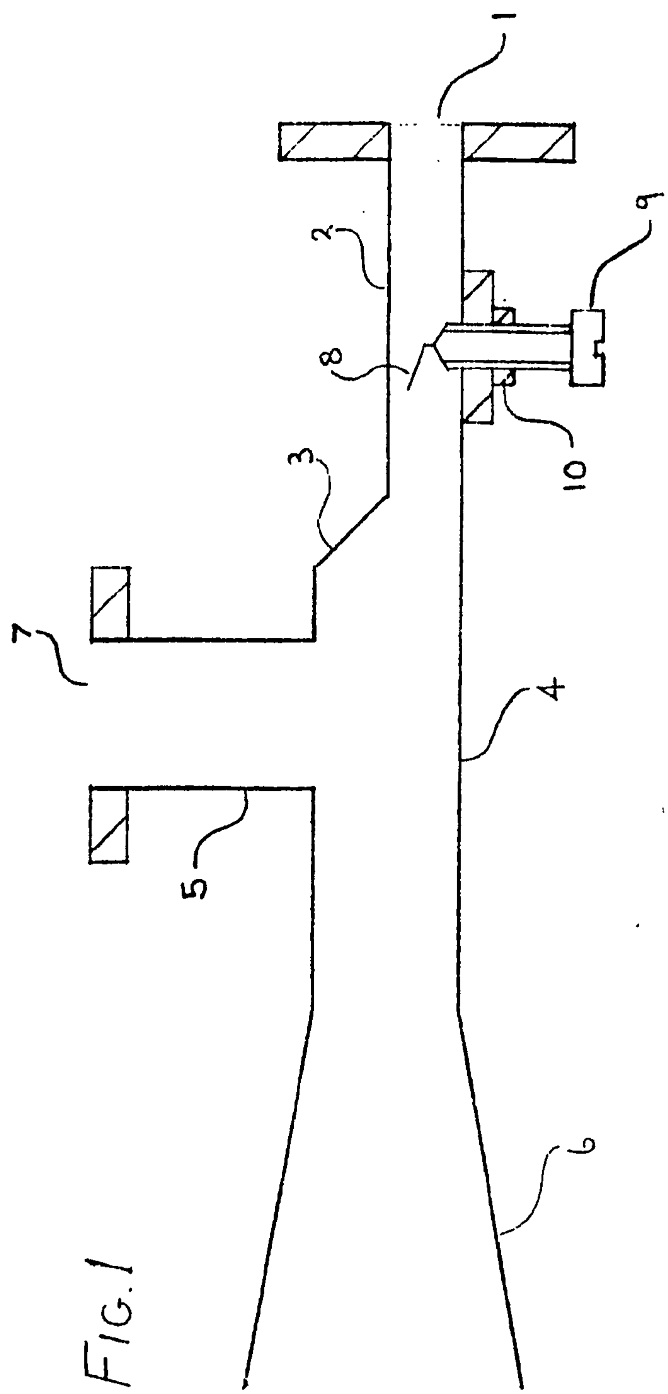

FIG. 1

SPECIFICATION

Polarization duplexer for microwaves

The invention to be described here constitutes part of a microwave transmitter/receiver system which transmits plane-polarized waves, and receives cross-polarized waves, that is the receiving section of the system does not respond to incoming waves having the same polarization state as the outgoing waves. Such systems are useful in the art of object detection and location by the transmission of electromagnetic waves and the observation of reflections of such transmitted waves from target objects; they make possible the reduction of the deleterious effects of reflections from objects other than those which it is desired to detect. For example there is described in U.K. patent number 945,008, published December 18, 1963, and granted to the Raytheon Company, a complex radar system operating in this manner, with the object of distinguishing between reflections from targets of interest and reflections from raindrops. This discrimination relies on the fact that raindrops reflect the transmitted waves without changing their state of polarization, so that the receiving section ignores such reflections, whereas when objects of interest reflect the transmitted waves their state of polarization is changed significantly. The invention is a simple device which could form part of such a system, and which is particularly useful when continuous wave transmission is employed, rather than pulsed transmission as in conventional radar.

An embodiment of the invention is shown in Fig. 1; waveguide 2 is rectangular in cross section, with its narrower wall parallel to the plane of the paper. Its dimensions are such that it will transmit only one microwave mode at the frequency in question, the so called TE_{10} mode, which is linearly polarized with the electric vector parallel to the narrow wall. The choice of such dimensions is well-understood, and a range of standard rectangular waveguides is readily available, each member of the range covering a well-defined frequency band.

At 3a transition takes place to waveguide 4, of square cross-section, the dimensions of each side being equal to the broad dimension of rectangular waveguide 2. Waveguide 4 thus passes all modes of polarization. Waveguide 5 runs centrally into waveguide 4 at or near transition 3; waveguides 5 and 2 are identical in cross-section, but waveguide 5 has its broader wall parallel to the plane of the paper, and the polarization direction of its transmission mode is thus perpendicular to that of waveguide 2. In use microwaves enter port 1 of the device, and if not already linearly polarized are rendered so by the transmission characteristics of waveguide 2. These waves enter square waveguide 4 without significant depolarization and are launched into the environment by a suitable transmission device such as horn 6.

Waveguide 5 and port 7 form part of the receiving channel of the system. Waves leaving waveguide 2 and passing along waveguide 4 to the transmitting horn cannot enter this channel, as they have the wrong polarization; undepolarized reflections are similarly ignored. Only reflected waves which have suffered significant depolarization can enter the receiving channel.

As described so far, the invention falls within the scope of prior art, but has certain limitations. Owing to imperfections of manufacture, waves transmitted along waveguide 4 to enter the receiving channel to a small extent; it is difficult to achieve an isolation between the two channels of better than 40 dB with such a configuration. Although this means that only one part in ten thousand of the transmitted power enters the receiving channel, such a signal is often large enough in continuous wave systems to mask completely the weak reflected signals. This difficulty does not arise in pulsed radar systems, as the reflected pulses are received during the intervals between transmitted pulses. Invention is claimed with respect to a modification which overcomes this difficulty. The modification introduces a small extra signal into the receiving channel, to cancel out the undesired direct leakage between the transmitting and receiving channels.

This extra signal is generated by perturbing the transmitted waves slightly as they pass along waveguide 2. In this embodiment the perturbation is effected by a short piece 8 of fine wire, approximately equal in length to the narrow dimension of the waveguide, which wire is fixed at one end to a small screw 9 and inclined at an angle to the axis of the screw, which screw passes through a suitably threaded hole in the broad wall of waveguide 2. The position of this wire across the waveguide and its angle relative to the waveguide walls are adjustable using screw 9, which can be locked in position using locking nut 10. The two degrees of freedom of adjustment so obtained give corresponding freedoms in choosing the phase and amplitude of the perturbation, which freedoms can be used to minimize the undesired direct leakage. Almost any small object, suitably positioned in waveguide 2, will suffice to perturb the transmitted waves; the important point is that this object should be movable, and that the more degrees of freedom the movement has, the more accurately can the desired cancellation be achieved. Isolations of up to 70 dB between the two channels are achievable this way.

Although direct leakage between the transmitting and receiving channels is normally deleterious to the performance of these microwave systems, there are occasions when such leakage is deliberately introduced.

The signal so produced has fixed phase and amplitude, and is known as a reference signal. Incoming waves mix with this reference and the resulting signal is observed, for example to detect and measure the motion of targets of interest,

such motion producing a frequency shift in the reflected wave by the Doppler effect. When moved away from its position for optimum cancellation, the perturbing element 8 produces a controllable reference of this nature, which can be adjusted to suit the particular application.

Claims (filed on 4 Nov 1982)

1. A microwave transmit/receive waveguide system which transmits plane polarized microwaves and receives only orthogonally polarized incoming waves, comprising a transmission channel which supports only the transmitted mode of polarization, which channel makes a transition to a common transmit/receive channel which supports simultaneously both transmitted and received polarization modes, into which common channel leads a reception channel which supports only the received polarization mode, said transmission channel having means for perturbing the transmitted waves, which perturbation can be adjusted in both phase and amplitude.

2. A microwave system as claimed in Claim 1 in which means for perturbing the transmitted waves consist of a small object of metallic or dielectric nature, suitably suspended in the transmission channel, means being provided for adjusting with up to three degrees of freedom the position of said object.

3. A microwave system as claimed in Claim 2 in which the small object consists of a short length of fine wire fixed to the end of a screw passing through a tapped hole in the wall of the transmission channel, said length of wire being at an angle to the axis of the screw.

4. A microwave system as claimed in Claim 1, 2 or 3 in which the freedom of adjustment is used to minimise internal leakage of power from the transmission channel to the reception channel.

5. A microwave system as claimed in Claim 1, 2 or 3 in which the freedom of adjustment is used to introduce a fixed reference signal into the receiving channel.

6. A microwave system substantially as described herein with reference to the accompanying drawing Fig. 1.

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